Industrial Standardization

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MOST of us talk of standardization in a vague way, usually having in mind some particular corner of the subject, but without full realization of the comprehensiveness of the word, of the magnitude and importance of the field covered, or that the coöperation without which our modern society would be impossible would in turn be impossible without a large measure of standardization. It might almost be said that the degree of standardization in any nation is a measure of its civilization, certainly in the material sense of the word.

Even in the tribe a common language was necessary, namely a standardization of the meaning of words. A dictionary is merely a recorded standardization of the spelling, pronunciation and meanings of words, as determined by usage and common consent. Without the stabilizing influence of such records any language would be in a state of confusing and undesirable flux. To be sure we still have dialects and colloquialisms, but these are gradually decreasing. In civilized intercourse the accurate use of words is absolutely essential to mutual understanding, however rare it may be. Between nations we still have many different languages although most of the civilized world now uses substantially the same alphabet and there is a persistent effort to establish a universal language.

The next steps in standardization were in coinage, weights and measures. Our present Bureau of Standards is the outgrowth of the old Bureau of Weights and Measures, which was merely the repository for standards of weights and measures. Imagine the hopeless confusion in this country if each state had its own system of coinage and of weights and measures. Even between nations differences in languages, coinage, weights and measures, constitute barriers to intercourse, social and commercial, which tend to prevent interchange of ideas and commodities and thus to retard that mutual understanding which makes for peace.

But standardization has already extended far beyond these

fundamental fields and is now growing with leaps and bounds. A brief classification and review of each field may be of interest, excluding the alphabet and coinage as outside of the engineering and industrial group.

Classification of Standards

Language. Definitions of scientific and technical words, terms, phrases: Abbreviations, symbols and diagrams. Standardization of these elements of our technical language is just as fundamental to intelligent intercourse in this field as in the case of ordinary intercourse; in fact it is more fundamental since we are here dealing mostly with accurately measurable quantities.

Standards of Quantity. Length, area, volume, mass, weight, density, pressure, heat, light, electricity, magnetism, radioactivity—physical constants and their relation to each other.

Standards of Quality. Specifications for materials together with standard methods for testing their qualities.

Standards of Performance. Operating characteristics of machines and devices: Output, rating, speed, efficiency, durability, etc., as specified in terms susceptible to measurement.

Standards of Practice. Regulations or codes dealing with construction, installation and operation, based upon considerations of safety, quality, economy, convenience, etc.

Standards of Type. Standardization of definite types or varieties to the end of reducing the number of types and the cost of production.

Dimentional Standards. In any product the standardization of sizes or sets of dimensions in order to reduce the number of sizes and the cost of production.

Need and Value of Standardization

This would hardly seem to need argument, but a few illustrations may not be out of place.

Some years ago a friend purchased an automobile which had nearly as many sizes and types of bolts as there were bolts on the car, with a resulting inconvenience almost unbearable. Since that time the Society of Automobile (now Automotive) Engineers has carried on a tremendous campaign of standardization which has not only vastly reduced the annoyance of repair work to the

purchaser but has greatly reduced the cost of automobiles. It is also largely responsible for the primacy of this country in that field.

Another illustration from the same field was when the same society started to standardize steel tubing. All the manufacturers agreed except one who persisted in his odd sizes. Shortly thereafter this manufacturer, wishing to purchase some steel tubing, asked for prices and shipment. He found that the price would be about 30 per cent higher than for the standard sizes, and that the shipment would be made in three months as against immediate shipment of the standard sizes from stock.

An illustration from the electrical field has to do with the rating of electrical machinery. In the early days there was no agreement as to what was meant by a ten horsepower motor, and fair competition was impossible. The ratings of the several manufacturers varied as much as 30 per cent and the customer was at the mercy of the pursuasive talents of the salesman. It took the Standards Committee of the American Institute of Electrical Engineers five years to develop a system of rating satisfactory to all concerned and capable of reasonably accurate checking by commercial tests. The results of this work have proved to be of world-wide value.

In certain fields, notably in standardization of types and in the dimensional standardization when the latter is carried into complete designs, there is an obvious danger that standardization may develop into crystallization and serve as a brake on progress; but this is merely a danger and not an obstacle, since it is obviously possible to keep the standards abreast of progress. Moreover standardization of national scope rarely extends beyond those fundamentals in which changes are not likely to be desired, although the difficulty of making a change is the greater. A notable example of this is our abominable English system of weights and measures which just "happened" in those early days when the importance of a national system was not appreciated.

INDUSTRIAL STANDARDIZATION IN THE UNITED STATES

Up to within a comparatively few years the work of industrial standardization in this country has been largely of sporadic nature, without any appropriate or authoritative organization for

its conduct. One of the best typical illustrations is that of machine screw thread standards, one of the most fundamental and important matters in the whole field of industrial standardization.

Screw Threads, Bolts, Nuts, etc. In 1864 a committee of the Franklin Institute recommended the adoption of a system devised by William Sellers, now known as United States Standard. In 1884 Charles Bouer of Warder, Bushnell & Glessner, Springfield, Ohio, adopted standard sizes of screw threads for bolts and taps, based upon the United States Standard screw thread. In 1895 the American, Hartford and Worcester Machine Companies issued standards for set-screws and cap-screws, also based upon the United States Standard screw thread. In 1906 the Association of Licensed Automobile Manufacturers adopted standards for automobile screws and nuts.

In 1907 the American Society of Mechanical Engineers accepted the report of its committee on standard proportions for machine screws. This committee was appointed in 1902, and had devoted five years to the task. As far as the screw threads themselves are concerned, the American Society of Mechanical Engineers standard differs only in very minor details from the Sellers' or United States Standard, but the report of the American Society of Mechanical Engineers gives standards also for taps, special screws, special taps, and screw heads of various types, together with tolerances.

In 1912, the Society of Automobile Engineers was organized and has adopted fine screw thread standards, as well as many other size standards of automobile materials and parts.

In the fall of 1918 a screw thread commission was appointed by act of Congress and is still at work. In this work some consideration is being had of the international situation, and, although there are obviously great difficulties in adapting our threads in those of the metric system nations, the differences between the United States and the British threads are slight.

Wire and Sheet Metal Gauges. Another illustration is in connection with gauges for wires, drills, and sheet metal. Of these there are several varieties still in use, although for copper wires, the Brown & Sharpe or American wire gauge is most commonly used for the smaller sizes, and the Edison or circular mil gauge for all sizes above 0000 B. and S. All these gauges were originally

adopted by some individual such as the twist drill gauge of the Morse Twist Drill & Machine Company, the Stubbs steel wire gauge, etc.

An act of Congress in 1893 established the Standard gauge for sheet iron and steel. Previous to this time there were many gauges in use, and the addition of this one seemed only to add to the confusion. In 1895 a joint Committee of the American Society of Mechanical Engineers and the American Railway Master Mechanics Association agreed to recommend the use of the decimal gauge,—that is a gauge whose number is the thickness in thousandths of an inch,—and to recommend the abandonment and disuse of the various other gauges then in use. In 1904 the Westinghouse Electric and Manufacturing Company abandoned the use of gauge numbers referring to wire, sheet metal, etc. There are now at least eight different sheet metal gauges in use in this country.

Apart from the standardization by individual manufacturers in the haphazard method illustrated above and still in operation to a considerable extent, standardization in this country is largely in the hands of a comparatively small number of our national societies, and the United States Bureau of Standards. The standardization work of these societies is briefly outlined below.

American Society of Mechanical Engineers. Until within the past few years the standardization work of the American Society of Mechanical Engineers was done by special committees which reported directly to the society. Now there is a central standardization committee with general supervision over the work of the special committees dealing with particular standards. The constitution of this society forbids the *adoption* of standards, but the effect is practically the same since the reports of the committees are accepted by the society and distributed as indicating approved practice.

Some of the subjects covered are as follows:

Thickness gauge for metals; machine screw threads; pipe threads and flanges; pipe unions; special threads for fixtures and fittings; locomotive and engine tests 1890; power test code 1915, being performances tests of power plant apparatus; boiler code in 1914, being standard specifications for the construction of steam boilers; standard tests and methods of testing materials.

In this last mentioned field the American Society of Mechanical

Engineers held sway from 1889 until 1898 when there was organized in Philadelphia the "American Section of the International Association for Testing Materials," which was incorporated in 1902 as the "American Society for Testing Materials."

American Society for Testing Materials. This society is highly and efficiently organized to cover the whole field of materials including: Structural timber; steel for all purposes including railway rolling stock, rails, structures, and castings of all kinds; standard magnetic tests of iron and steel; copper for electrical and other purposes; bronze; cement; fire proof materials; road materials; paint; coal; etc. There are thirty-eight standing committees with a total membership of about one thousand.

Society of Automotive Engineers. This is a very active society organized in 1912, which has accomplished wonders in the field of automobile manufacture. The work of its standards committee might be best characterized as dimensional since it deals largely with the standardization of sizes and parts. The aircraft work was undertaken in 1917 and aircraft standardization begun.

American Institute of Electrical Engineers. The standards Committee of the American Institute of Electrical Engineers was first appointed in 1898, to develop standards for electrical machinery and apparatus. The main committee comprises over thirty members, and the thirty odd subcommittees include many more. The ground covered includes:

Definitions; rating, performance and testing of all types of electrical machinery; wires and cables; switches, cricuit-breakers and control apparatus; meters and instruments; telephone and telegraph; etc.

The work of this committee is accepted as authoritative in its field and has been followed to a considerable extent by similar bodies in European countries. After the illuminating engineers and radio engineers formed societies of their own with their own standards committees, their rules, somewhat abbreviated, have been printed as parts of the American Institute of Electrical Engineers rules, with a note as to their origin.

Electric Power Club. This organization includes about 90 per cent of the electrical manufacturing interests of this country. Its work in electrical standardization takes the American Institute of Electrical Engineers rules as a basis and extends them to cover many special cases. It also includes some dimen-

sional standards, name plate data and other details of interest to the manufacturer.

National Electric Light Association. The Electrical Apparatus Committee of the National Electric Light Association deals with such special standards as they find to be needed in the operating field, and not covered by the American Institute of Electrical Engineers or electric power club rules,—*e.g.*: Standardization of sizes, voltages and taps for transformers, terminal markings for transformers, uniform service rules for motors, etc.

Both the National Electric Light Association and the Electric Power Club are in close coöperation with the American Institute of Electrical Engineers in their work of standardization.

United States Bureau of Standards. The bureau was established in 1903 and although there had been previously a Bureau of Weights and Measures, it was merely a receptacle for the standards of length, weight, etc., and not an active bureau of standards. The work of the present bureau has expanded enormously since its inauguration, its total appropriation during 1918, including that for buildings, having been over $3,000,000.00.

The ground covered is given in a separate article.[1]

National Fire Protection Association. Amongst other fire protection codes this association is responsible for the national electric code which was first issued in 1897 with a revision every two years. This code does not conflict with but runs parallel to the national electric safety code of the Bureau of Standards which deals more specifically with safety to life.

Railway Standards. There are several associations in the United States, notably the Master Mechanics and Master Car Builders Association which prepare standards for railway construction.

Other Industrial Standards. Numerous other organizations of a less technical nature prepare standards in their particular fields.

MACHINERY OF STANDARDIZATION

As the need of standardization has grown, the work has been undertaken by existing organizations or by new organizations created for the purpose in special fields. But it often if not usually happens that a group of standards undertaken by one society

[1] See page 247.

is of great interest to several others. Thus the need for comprehensive coöperation has grown rapidly during the past few years.

The value of a standard depends upon its acceptability to all concerned with its use. No good results from the issue of a standard not thoroughly prepared and acceptable to all, as the resulting situation would be similar to that in which each community creates its own language.

A consideration of the above brief history of American industrial standardization will make clear the absence of any well developed machinery of coöperation between the numerous bodies interested in any group of standards, and of an authoritative body whose approval will be evidence that the standard in question has been thoroughly worked out and has the approval of all the interests concerned, for only then will the standard be of real value. To meet this need there has been recently created the American Engineering Standards Committee, whose organization and method of procedure is outlined below.

American Engineering Standards Committee

The American Engineering Standards Committee was formed by joint action of five national engineering societies (American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers and the American Society for Testing Materials), called the "founder societies," to meet a long felt need of some available and satisfactory machinery for the development of engineering and industrial standards, by the operation of which duplication would be avoided and coöperation between all interested organization and government departments secured; so that when a standard or group of standards is developed it will be acceptable to all concerned and will, therefore, be a real American standard. Moreover as international standardization develops, there is imperative need for an authoritative national body to deal with the corresponding foreign bodies. National engineering standards committees are already in operation in England, Canada, France and Holland, and others will undoubtedly be organized in the near future.

The American Engineering Societies Committee now proposed for the development of standards is made up as follows:

(a) The committee proper or the "main committee" (with three representatives from each of the five "founder societies" and three government departments), whose functions are chiefly those of an organizing, coördinating and steering committee.

(b) "Sectional committees," one for each group of standards (with representatives from all organizations or government departments vitally interested in that particular group of standards), whose function is to prepare the standards in question under the direction of the most vitally interested organization known as the "sponsor body."

(c) The "sponsor society" or "body" may be one of the founder societies, a government department, or one of the "Co-operating Societies" of organizations.

(d) Under "cooperating societies" it is intended to include all organizations interested in the production of standards and willing to coöperate.

Procedure. (1) When the development of a particular group of standards is proposed, the main committee assigns the work to the appropriate organization as "sponsor," or, if the situation seems to indicate that more than one organization is equally interested, to these organizations as "joint sponsor."

(2) The sponsor then appoints the sectional committee subject to the approval of the main committee. The purpose of this approval is merely to assure the comprehensive representation of all the interests involved. Complete records of all interested organizations and of their standardization work and connection, will be kept on file and properly classified in the office of the main committee. The main committee or its secretary will thus be able, either promptly to suggest the proper representation to a sponsor on request, or to approve or amplify the representation as provisionaly proposed by the sponsor.

(3) After a group of standards has been prepared and accepted by a sectional committee, it is submitted to the sponsor body for its approval and then to the main committee with a full report of its history. When approved by both the sponsor body and the main committee, the standards in question become American Standards.

(4) When the report of any sectional committee is being considered by the main committee, three members of that sectional

committee are invited to sit with the main committee to report, discuss and vote on the standards in question as if they were regular members of the committee. Thus each sectional committee (and therefore usually each sponsor body) will be represented on the main committee when standards in which they are interested are being discussed.

(5) The scrutiny of a standard by the main committee is to make sure that the proper procedure was pursued, that it was prepared by a comprehensively representative sectional committee, that the vote of acceptance was nearly enough unanimous, and that the standard is consistent with other related standards. Consideration is also given to international relations; but the main committee is not supposed to pass upon the details.

(6) After approval by the main committee the standard is published by the sponsor body with the statement that it has been approved by the American Engineering Societies Committee, and labelled "American Standard" with the appropriate descriptive title.

Briefly summarized this procedure is as follows: Standard assigned by main committee to sponsor body. Sponsor body appoints a thoroughly representative sectional committee, subject to approval of main committee. Sectional committee prepares standard and submits to sponsor body which then submits the standard with its approval to the main committee. The standard is then published by the sponsor body and labelled "American Standard."

It is hoped that this movement will receive the hearty coöperation of all organizations interested in standards. If so it certainly will contribute largely to the industrial development of the country. Similar committees are already in operation in England, Canada, France and Holland. With all of these the American Committee is in coöperative touch.

International standardization has already been carried on effectively in the electrical field through the International Electrotechnical Commission, and there is every reason to expect that it will spread rapidly under the influence of the American Engineering Standards Committee to the great advantage of our foreign commerce. In the broad sense, international standardization means a common industrial language and the removal of one of

those barriers which tend to separate nations and to give rise to misunderstandings. The more of these barriers we can remove and the more we come to realize that our interests are after all in common, the more likely we are to attain that lasting peace for which the world longs.